PATENT ABSTRACTS OF JAPAN

(11) Publication number : 2000-131356
(43) Date of publication of application : 12.05.2000

(51) Int.Cl. G01R 23/165
A61B 5/044

(21) Application number : 10-305117
(22) Date of filing : 27.10.1998

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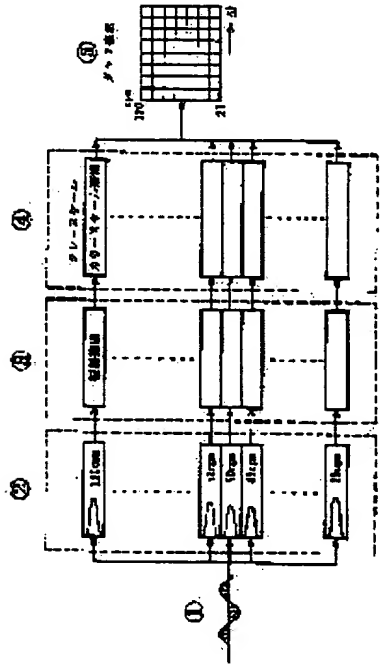
(54) SPECTRUM ANALYSIS AND INDICATION METHOD OF TIME SERIES DATA ORIGINATING FROM LIVING BODY



(57) Abstract:
PROBLEM TO BE SOLVED: To provide a spectrum analysis and an indication of time series data originating from a living body, whereby a change for a short time or a very week frequency change can be accurately known in the spectrum analysis of even such data changing within a short time as signals originating from a living body.
SOLUTION: To analyze time series data in spectra, bandpass filters 2 having cut off frequencies shifted by pass band widths are provided for the number of pass band widths under to process the time series data into frequency components, the amplitudes of the frequency components are extracted at fixed time intervals and converted in a gray scale or color scale, and the densities or colors corresponding to the converted amplitudes are indicated in the measured time lapse.

LEGAL STATUS
[Date of request for examination] 27.10.1998
[Date of sending the examiner's decision of rejection] 16.10.2000
[Kind of final disposal of application

other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection] 2000-17297

[Date of requesting appeal against examiner's decision of rejection] 30.10.2000

[Date of extinction of right]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention decomposes into a frequency component the time series data which digitized the signal resulting from a living body with the fixed time interval by A/D conversion etc., and relates to the approach of displaying a time change of the spectrum analysis approach of asking for the amplitude of the frequency component, and its amplitude.
[0002]
[Description of the Prior Art] Conventionally, spectrum analysis of time series data is mainly performed by the Fourier transform by FFT. Moreover, MEM (the maximum entropy method) in which spectrum analysis is possible is also used by short-time data. And it is common to perform these spectrum analysis by the fixed time period, and to display the result in a three-dimension graph.
[0003] However, in carrying out the Fourier transform of the biological information, when frequency resolution is raised, there is a problem that analysis time amount width of face (measurement time amount of data) required for analysis becomes long in proportion to this. For this reason, when the Fourier transform is performed to the data which change for a short time, if analysis time amount width of face is shortened, change of a frequency is not known, and if analysis time amount width of face is lengthened conversely and the resolution of a frequency is raised, change of the amplitude cannot be known correctly.
[0004] Furthermore, a short-time change or the problem of being undetectable also has change of a feeble frequency relatively by distribution of the spectrum resulting from the discontinuity of analysis section both ends peculiar to the Fourier transform.
[0005] Although it is important for the signal resulting from a living body to change for a short time in many cases, and to get to know the situation of the change, since the Fourier transform is used in order to grasp change of a frequency, its analysis time amount width of face is long, therefore it is difficult to get to know the situation of changing with these for a short time.
[0006] For example, considering an electrocardiogram, only 1cpm (cycle per minute), then the information to which the analysis result was averaged for 1 minute are acquired in frequency resolution. however -- as what has a change of the amplitude obtained by carrying out the Fourier transform of this common [arrhythmia] that it is change for several seconds and very small -- appearing -- not passing --

this -- with, the situation of change cannot be known.
[0007] Moreover, in the case of MEM, since the value of the obtained amplitude is indefinite and spectrum distribution does not have data and correlation, this technique is not employable as an electrocardiogram. As shown in an electrocardiogram, when the detail understands wave-like semantics, it is unsuitable to adopt the spectrum analysis which cannot trust the amplitude of a feeble frequency.
[0008] Furthermore, although being displayed on a three-dimension graph is common as for the result of having carried out spectrum analysis at fixed spacing, in such the method of presentation, the mask of the amplitude feeble at a front spectral display will be carried out, and there is another problem that it becomes difficult to grasp a time change. Moreover, even if it displays the result of the conventional spectrum analysis by the color map, the condition of changing for a short time can be grasped, and it will not become useful if the amplitude of a feeble frequency is not the right, either.
[0009]
[Problem(s) to be Solved by the Invention] As mentioned above, the approach of the Fourier transform by FFT conventionally used for the spectrum analysis of time series data, or MEM Since many problems arise in adopting it as the spectrum analysis of the data which change to the inside of a short time like the signal resulting from a living body Even if this invention is such data, let it be a technical problem to offer the spectrum analysis approach of time series data and the method of presentation resulting from a living body which close change and getting to know change of a feeble frequency correctly relatively between short time if in the spectrum analysis.
[0010]
[Means for Solving the Problem] This invention solved the above-mentioned technical problem with a means to analyze the band pass filter which shifted pass-band-width [every] cut-off frequency and for bandwidth to carry out part preparation, to process time series data with each band pass filter, and to decompose into a frequency component, in order to decompose time series data into a frequency component. In this means, it becomes possible to detect a short-time change by using a band pass filter, and since the spectral decomposition with a filter processes continuously, there is [no distribution of the spectrum resulting from the discontinuity in the Fourier transform]. This enables it change and short-time to get to know change of a feeble frequency correctly relatively.
[0011] The response time decomposed into a frequency is about 6 seconds in a band pass filter with a pass band width of 1cpm, although it is dependent on the time delay of a band pass filter. This is 1/10 compared with the analysis time amount width of face of the Fourier transform, and means that a short-time change can be detected. Furthermore, if the pass band width of a band pass filter is extended, the response time will become short in proportion [almost] to it.
[0012] In the method of presentation concerning this invention, the filter group constituted from a band pass filter decomposes into a frequency component, the amplitude of each decomposed frequency component is extracted with a fixed time interval, each of that extracted amplitude is changed by gray scale or KARASUKE-RU,

and graphical representation of the shade or color corresponding to the changed amplitude is carried out according to the measured time amount progress. By doing in this way, it becomes possible for the situation where a mask will be carried out by front display like a three-dimension graph not to occur, with to get to know a time change of the feeble amplitude. By decomposing into a frequency component by such approach, and carrying out graphical representation of the result, it becomes possible to grasp amplitude change of the whole spectrum clearly.

[0013]

[Embodiment of the Invention] The filter used for this invention is bandpass digital filter - for processing digitized time series data. Although there is no limit in the format of a filter, BATAWA-SUFIRUTA - by IIR (infinity impulse response) is usually used. Constituting the filter group which processes time series data from two or more band pass filters which shifted pass-band-width [every] cut-off frequency, a band pass filter prepares only the number of the frequency bands to analyze.

[0014] For example, with an electrocardiogram, if the frequency band analyzed with the pass band width of 1cpm is 20-120cpm, 101 filters with which passbands differ will be used. If extract processing is carried out with a band pass filter, the amplitude proportional to the reinforcement of the frequency component of a filter will be outputted. This is equivalent to the frequency component in the Fourier transform.

[0015] Moreover, processing with a filter is continuously performed to time series data. Diffusion of the spectrum which is produced in the case of the Fourier transform can be prevented by this, and it becomes possible to detect the amplitude of a feeble frequency correctly relatively.

[0016] If it is [the approach concerning this invention] based and it is explained to an accompanying drawing, one in drawing shows time series data, 2 will be a filter group and two or more band pass filters will gather. The data disassembled into each frequency component are processed in the amplitude extract group 3 by the filter group 2, and the amplitude is extracted with a fixed time interval.

[0017] In addition, the amplitude changes within the time amount to extract. Therefore, although it is good also as extracting the amplitude in the middle time amount of an amplitude extract, the wave which exists preferably in the time amount to extract is divided for every period, the amplitude of each period is extracted, and the averaged result is used.

[0018] The extracted amplitude data are transformed to the shade or color corresponding to the amplitude in gray scale or the Calah-scale transformation group 4. This conversion specifies the gain of a scale, and offset and is performed on conditions which the target information tends to acquire. The result changed on gray scale or the Calah-scale is displayed on a graph 5 according to elapsed time and a frequency.

[0019] Although various methods of presentation of a graph are considered, the changed shade (refer to drawing 2) or color of a result corresponding to each of that intersection is displayed by making an axis of ordinate into a frequency as one example, making an axis of abscissa as the elapsed time of data. This approach showed a time change of frequency distribution by one division, and it became

possible by the conventional approach to grasp change of the whole spectrum also including the unclear feeble frequency component.

[0020] Next, the example of an operation of the band pass filter currently used concretely is shown. This filter is A/D-conversion rate 10 sample / second, the center frequency of 50cpm, the pass band width of 1cpm, and the example that constituted 4th BATAWA-SUBANDO pass filter - from concatenation mold 1D.

[0021]

- Filter constant num[0] =1.0, num[1] =0.0, num[2] =-1.0, num[3] =1.0, num[4] =0.0, num[5] =-1.0;

den[0] =1.0, den[1] =-1.7178023, den[2] =0.98955997, den[3] =1.0, den[4] =-1.7283111, den[5] =0.98974543;

scale=0.000053534792;

[0022]

- Operation sum=dataxscale;

for(i=0;i<2;i++) {aw=num[ix3+1] xdelay[2xi]+num[— ix3+2 —]

xdelay [2xi+1];

bw=den[ix3+1] xdelay[2xi]+den[ix3+2]

xdelay [2xi+1];

wo=sum-bw;

sum=woxnum[ix3]+aw;

delay[2xi+1] =delay [2xi];

delay[2xi] =wo;

}

Time series data are inputted into "data" and it outputs to "sum."

[0023]

[Effect of the Invention] This invention is as having mentioned above, if this invention is used, the spectrum analysis of the time series data which change for a short time will become possible, and decision will become possible [grasping change of the difficult feeble frequency component easily] until now.

[0024] When an electrocardiogram is taken for an example, an electrocardiogram is strong data of regularity and the part which shows a certain abnormalities is a part in it very much in many cases. Although the approach of usually making fluctuation of an R-R interval into an index, and looking for an abnormality part has been taken since the data which carried out long duration measurement using the Holter electrocardiograph will become huge, fluctuation of an R-R interval is not a big problem in many cases, and its possibility of having overlooked the various precious information included in the electrocardiogram is high. When graphical representation of the result of spectrum analysis is carried out using this invention the place where it is known that various clinical knowledge will be acquired from a wave-like detailed change, an electrocardiogram can recognize change of a detailed signal at a glance, and becomes possible [finding out an abnormality part simply] from a vast quantity of data covering long duration.

[Translation done.]